CHAPTER 1

Introduction

### EVOLUTION OF POLLUTION PREVENTION (P2)

Pollution prevention (P2) has evolved substantially in its first decade. In 1988, the U.S. Environmental Protection Agency (EPA) published the *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003). It contained over 34 pages of checklists and worksheets and focused on hazardous waste minimization. The first revision, *Facility Pollution Prevention Guide* (EPA/600/R-92/088), was released in 1992. It contained only 10 pages of checklists and worksheets, and added new topics, including energy conservation and the design of environmentally compatible products. The EPA distributed many copies of these publications to requestors in the United States and internationally, and the information was well-received by the environmental community. The EPA prepared many successful project reports and case studies based on this approach. Copies of these publications are available on the CD-ROM that accompanies this *Guide*, and the "traditional" P2 approach that they describe is covered in Chapter 5 of this *Guide*.

This *Guide* presents an alternative approach to implementing P2 in your organization. As you will see, it documents how P2 is moving from a specialized environmental initiative to a mainstream business activity. Employees can now become increasingly involved in P2 and reduce their reliance on "outside experts" using defined checklists and databases of "proven solutions" that may overlook P2 opportunities. Employees can use process mapping to better understand the organization's main and supporting processes and widely accepted problem-solving and decision-making tools to find new P2 opportunities and prepare cogent, written action plans. Many business managers are already familiar with these tools since they are already used to improve operations. No matter what method is selected to implement P2 activities, these tools should help improve communication within an organization and communication with other interested parties. This *Guide* is intended to assist any organization in developing, implementing, and maintaining a P2 program. It should help your organization decide which program elements to include and the general approach for sustaining this important business practice.

During the evolution of P2, some environmental professionals have continued to focus on regulatory compliance. This has been a reactive focus, as compliance activity is usually undertaken in response to a new or changed regulation at the Federal, state, or local level. Prevention, on the other hand, is anticipatory. Action is taken not on the waste or use of a regulated material, but on the circumstances and conditions that may generate waste or a regulated material. The focus in P2 is on
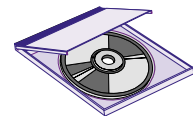
This Guide *presents an alternative approach to implementing P2 in your organization.*

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Lean generally focuses on "the elimination of all waste from all business practices."

This Guide *focuses on the integration of P2 into core business practices.*

Many advocates for sustainability seek not merely to reduce waste but to eliminate the generation of waste altogether.

Having a strong P2 program is a vital aspect of any program that is set on eliminating wastes from the organization.

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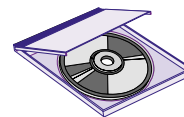
Many states have enacted P2 and toxics use reduction planning legislation. This legislation has had the unintended effect of making P2 a regulatory compliance effort and has done little to integrate P2 into core business practices. It is important to understand the organization's main and supporting processes and all of the individual work steps so that when the process is changed, the regulatory requirement is not triggered. By seeking to avoid the need for regulatory compliance (i.e., compliance through P2), environmental professionals become important resources to the organization's work function; managers of organizations are beginning to recognize the value of these environmental professionals as they reduce the costs associated with compliance activities.

An organization's management is always searching for the newest trend to enhance its value and financial viability. Many organizations use a version of a management practice called lean manufacturing. Lean generally focuses on "the elimination of all waste from all business practices*."* Much has been written on seven types of organizational wastes: over-production, waiting time, transport, variable process, inventory, motion, and defective goods. Environmental wastes are rarely included in these programs because many organizations rely on the environmental function to manage these wastes in accordance with regulations. Many organizations with a strong focus on quality have weak P2 programs because the environment and quality programs have not been sufficiently integrated. This *Guide* focuses on the integration of P2 into core business practices. It will present P2 as a necessary component of many common organizational management programs and show you how to use the same problem-solving and decision-making tools used in these programs.

Many advocates for sustainability have called for a shift to biologically-inspired production models. They seek not merely to reduce waste but to eliminate the generation of waste altogether. As a result, there is a growing trend for organizations to set goals of zero wastes and/or zero emissions. Organizations like DuPont, Xerox, Collins Pine, and Interface have joined these ranks. The zero-waste trend stems from a long-standing tradition of setting zero defects, zero injuries, and zero incidents goals. Having a strong P2 program is a vital aspect of any program that is set on eliminating wastes from the organization. However, integrating a strong P2 program with many other programs in the organization is still essential to realizing these goals. Some organizations are implementing programs that direct them toward a sustainable performance level. Elimination of wastes and conservation of resources are important first steps in such programs.

This *Guide* is not intended to be an exhaustive review of case studies and company examples. In order to keep this *Guide* to a reasonable length, examples have been cited in the references section of each chapter and links have been provided in the CD-ROM that accompanies this *Guide*. In addition, many EPA and other programs support P2 efforts; e.g., Environmentally Preferable Purchasing (EPP), Design for Environment (DfE), Environmental Accounting Project (EAP), P2 Resource Exchange (P2Rx) and a number of other voluntary programs. Links to these programs are provided on the CD-ROM. This CD-ROM will also provide more detailed supporting information on many of the concepts described in the *Guide*.

BENEFITS OF P2

The benefits of practicing P2 have long been noted. Despite the clear advantages, however, some managers are still reluctant to recognize the P2 efforts that are underway in their organizations. To provide better focus on the benefits, environmental coordinators are now showing how P2 is enhancing other management initiatives by linking P2 to the core values of the organization. It may be best to think of the following categories of benefits in this new light.

- Reduced operating costs
- Improved worker safety
- Reduced compliance costs
- Increased productivity
- Increased environmental protection
- Reduced exposure to future liability costs
- Continual improvement
- Resource conservation
- Enhanced public image

Reduced operating costs. P2 activities usually save an organization money in the long term. Many P2 projects have good returns on investment and short payback periods. Even if an organization is not subject to complicated regulations, P2 can still result in cost savings by reducing energy and water use while increasing materials productivity. Organizations may also save money in solid waste disposal costs, new material costs, and improved operating efficiency. Unfortunately, too few P2 professionals communicate the economic benefits of P2 progress to management.

Improved worker safety. Reducing the use of toxic materials in the workplace should be a major component of P2. By reducing or eliminating toxic substance use, the safety of the work environment can be improved and the use of personal protective equipment requirements decreased. Also, reducing the likelihood of leaks, spills, and harmful releases can decrease worker, visitor, and contractor exposure to those

substances. These steps will produce cost savings through material loss prevention and may result in reduced insurance rates as medical claims and disability leaves decrease. Better labor relations can also result from improved worker safety. Unfortunately, there have been cases where P2 activities have *inadvertently* decreased worker safety hazards (e.g., substituting the flammable solvent isobutyl alcohol for the halogenated solvent 1,1,1-trichloroethane which is non-flammable but a worker health issue). It is important that P2 does not trade off environmental improvement with workplace health and safety. Ergonomics can also be influenced by P2 efforts.

Reduced compliance costs. Undertaking P2 projects can reduce regulatory exposure and, in some cases, eliminate the need for permits, manifesting, monitoring, and reporting. This is referred to as *avoiding the need for regulatory compliance.* Keeping up with regulatory requirements and submitting the required reports can be an expensive and time-consuming process that, if eliminated, saves money. For example, the U.S. Air Force has initiated a program known as Compliance Through Pollution Prevention (Reference 1-1). The Air Force is trying to achieve and remain in compliance by using P2 instead of classical environmental engineering and regulatory compliance techniques. Some organizations have been able to change their regulatory compliance status (e.g., move from a large quantity generator of hazardous waste to a small quantity generator) through the use of P2 activities.

Increased productivity. P2 can improve an organization's material productivity through more efficient use of raw materials due to improved processes and operations. For example, an organization that produces large quantities of wastes (discharges, emissions, spills, and leaks) might be using old technologies to produce its products, or its processes might be poorly controlled and inefficiently operated. Sometimes small process improvements involving material substitutions and changes in operating procedures can result in increased product yield and better quality.

Increased environmental protection. Many waste disposal and treatment methods are less protective of the environment than previously estimated. These methods may only move environmental contaminants from one medium to another. They may cause problems in the future that are not yet apparent. P2 reduces the generation of wastes (discharges, emissions, spills, and leaks) at the source, resulting in less toxic waste, and thus assures improved environmental protection.

Reduced exposure to future liability costs. Reduction of potential long-term liability from waste disposal, emissions, and discharges has become an important concern in recent years. Some past disposal practices, although legal, have caused environmental damage for which organizations have been held liable, creating a large liability expense and damaging their public images. P2 can help reduce long-term liability by reducing the amount and toxicity of waste generated.

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Continual improvement. Successful implementation of a P2 program can be an integral part of a company's continual improvement or quality improvement program. Reducing wastes and improving efficiency are goals of both P2 and continual improvement. Many organizations use continual improvement to constantly change certain work processes in order to improve them. To clarify the use of the term "continual improvement," the following distinction is made:

> "Continuous improvement—happening all the time, everything moving forward at once; often used in quality programs"
>
> "Continual improvement—happening all the time, but not everything moving forward at the same time and rate; often used by auditors of Environmental Management Systems and in other environmental programs."

The term continual improvement is used throughout this text.

Resource conservation. P2 will lead to the use of less energy and water. All resources, materials use, and waste reduction can be monitored in the same program. Traditionally, most organizations had separate programs (e.g., water conservation or energy efficiency) for resource conservation and P2. However, these programs are related in many ways; both are necessary to improve efficiency and to meet the organization's goal of sustainability.

Enhanced public image. P2 can help an organization gain a favorable image with the community by showing that they are willing to make changes to improve the environment and move towards sustainability. Some organizations have used their "green" image to successfully distinguish themselves in the marketplace, thus adding to their intangible goodwill market value.

IMPEDIMENTS TO P2 USE

A number of impediments commonly hinder successful implementation of a P2 program. It is important to recognize these impediments and address each of them during implementation. Management's commitment to addressing these issues is a key element of the success of the P2 program.

- Capital requirements
- Specifications
- Regulatory issues
- Product quality issues
- Customers' acceptance
- Immediate production concerns
- Organization image concerns
- Available time/technical expertise
- Inertia

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Capital requirements. Implementation of P2 measures might require capital investment. Such projects may need to be justified economically and are subject to the availability of capital in the organization. Capital justification protocols may not recognize the "hidden" costs that are avoided and the reduction in the organization's financial overhead burden resulting from P2 measures.

Specifications. Specifications can be both an incentive and an impediment. For instance, specifications may stipulate certain materials be used in the manufacture of a product, or that virgin materials be used rather than recycled. This can lead to the use of materials that are damaging to the environment, or the unnecessary use of virgin materials where recycled would suffice.

Regulatory issues. It may be necessary to obtain a new or modified permit or other governmental approval before implementing a process change or material substitution. This can be time-consuming and costly. For example, if a process is regulated by the Food and Drug Administration (FDA), all process changes require submittal of an application for approval, and new equipment must be inspected and approved by the FDA. In some cases, clinical trials of a substance, such as a drug, must be repeated to demonstrate efficacy. Unfortunately, P2 changes may occur faster than the government can respond. Many permit changes can take long periods of time to attain in even the most efficient governmental agencies.

Product quality issues. Organizations have great concern for the quality of the products and services they offer. Some P2 projects may affect product quality, even when properly implemented, and thus may be regarded with skepticism. For example, the use of mineral oils instead of mineral spirits (that have high volatile organic chemical [VOC] emissions) to carry dyes to fabrics may mean that some of the oils will remain on the fabric once it is dried, thereby changing the "feel" of the fabric and possibly the value of the finished product.

Customers' acceptance. The customer ultimately defines product quality; anything that affects the quality, or even the perception of quality, may affect acceptance by the customer. Customers often have a greater influence on how an organization operates than other outside parties. Some large organizations have encouraged their supply chains to adopt P2 behaviors to further the competitive advantage of the entire value chain.

Immediate production concerns. Implementation of P2 projects are often viewed by production as requiring time, money, and personnel, all of which are usually in short supply. Production quotas must be met as a first priority. After all, meeting the customers' demands is what pays the bills. However, production often finds the means to improve productivity, and P2 needs to be seen in this same light.

Organization image concerns. Organizations may be hesitant to admit that the "old way" may not be the best way. Once easy-to-implement P2 practices such as improved operations are underway, for example, some organizations may resist publicly acknowledging the changes out of concern that such acknowledgment might expose previous, less environmentally sound practices. However, the implementation of P2 practices provides managers with an opportunity to lead the organization through changes that will benefit everyone.

Available time/technical expertise. Some organizations may lack sufficient time or technical expertise to develop and implement P2 practices. Even though many state and federal technical assistance programs (References 1-2, 1-3, 1-4) are available at little or no cost, some organizations simply fail to take advantage of them.

Inertia. Whenever a production system is in place and working with some degree of success, there is a tendency to leave well enough alone. The old adage "if it ain't broke, don't fix it" still prevails in most organizations. Overcoming resistance to change is a major challenge for P2.

P2 IN STEPS

Previous editions of this *Guide* have defined a path (adapted from Figure 3 in EPA/600/R-92/088) depicting how P2 should be implemented (see Figure 1-1).
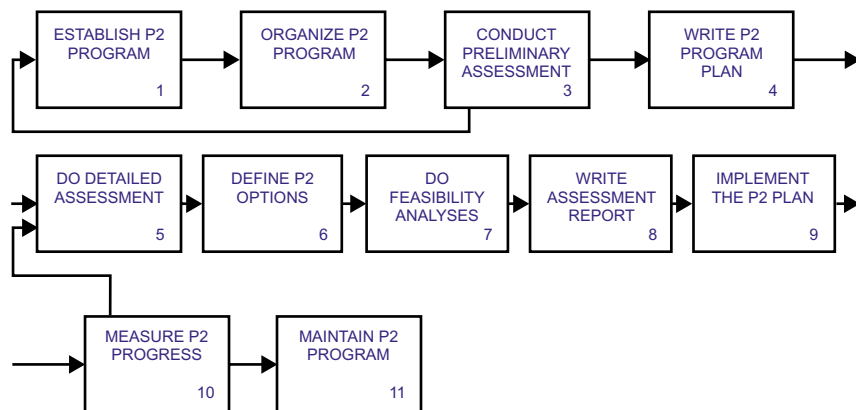

Figure 1-1. Process Map of a Traditional P2 Program.

Following is an alternative view of P2. The primary difference lies in the fact that the P2 Program is established after much of the information has been gathered rather than in the first step of the program. It also uses quality tools that have been adapted to P2 programs and published in the literature. This view of P2 consists of five simple steps (see Figure 1-2):

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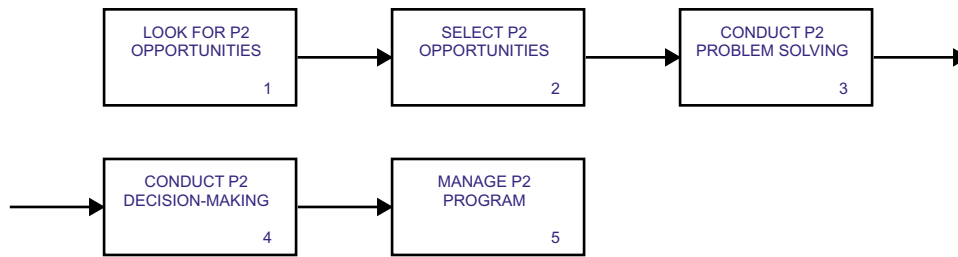
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┌──────────────┐      ┌──────────────┐      ┌──────────────┐
│ LOOK FOR P2  │      │  SELECT P2   │      │  CONDUCT P2  │
│OPPORTUNITIES │─────▶│OPPORTUNITIES │─────▶│PROBLEM SOLVING│────▶
│              │      │              │      │              │
│          1   │      │          2   │      │          3   │
└──────────────┘      └──────────────┘      └──────────────┘

      ┌──────────────┐      ┌──────────────┐
      │  CONDUCT P2  │      │  MANAGE P2   │
 ────▶│DECISION-MAKING│────▶│  PROGRAM     │
      │              │      │              │
      │          4   │      │          5   │
      └──────────────┘      └──────────────┘
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Figure 1-2. An Alternative Approach to a P2 Program.

While these steps will be discussed in more detail in Chapter 4 of this *Guide*, it is important to highlight some of the differences between the methods described here and the methods contained in the traditional approach to P2.

Step 1. Looking for P2 Opportunities

- Process mapping
- Main process/supporting processes
- Maps as information templates

The process maps become templates for maintaining information about the process.

All of the organization's processes are characterized in detail using a tool known as process mapping. This tool allows the information to be aggregated to a higher level when necessary. All supporting operations (ancillary and intermittent) are examined and linked to the main processes. Nothing is missed using this visual tool. All resources (e.g., energy, water, and materials) are accounted for at the work-step level (i.e., at the lowest level in the process maps as they define the actual work task that is being performed). The process maps become templates for maintaining information about the process. The costs of using and losing resources can also be collected by work-step using the process maps as templates. Traditional P2 methods have relied on a walk-through process assessment to gather information on P2 opportunities.

Step 2. Selecting P2 Opportunities

- Rank ordering
- 80/20 rule
- Pareto chart
- Monetary metrics

Every process in every organization will produce P2 opportunities.

Every use of a resource in a process represents an *opportunity* to conserve the use of that resource. Every loss of a resource in a process represents an *opportunity* not to lose that resource. Every process in every organization will produce P2 opportunities. It is possible to rank P2 opportunities using monetary units and also to construct a Pareto chart. This chart will show that 20% of the P2 opportunities represent 80% of the true costs of environmental management of the uses and losses. No matter how the P2 opportunities are selected, it is important to have the organization keep its collective eye on the most important ones. Many organizations select a manageable number of P2 opportunities to work on each year. Ideally, P2 opportunities should be selected from every department in the organization to ensure that everyone stays involved.

Step 3. P2 Problem Solving

Once the P2 opportunities are selected, the use and loss of resources are seen as "problems." Worker teams are assembled to address these problems using root cause analysis to first ask *why* each is a problem. A simple cause and effect (fishbone) diagram can help the team examine how materials, machines (technology), methods, and labor contribute to the problem. This visual tool can communicate the causes of the problem to all levels of the organization. In fact, the cause-and-effect diagram is the most widely used problem-solving tool in the world.

With this important information gathered and analyzed, the team can now search for alternatives to solve the problem using tools like brainstorming and brainwriting. It is important to remember the adage that "the only way to find a good P2 alternative is to find many alternatives." In the past, many P2 problem-solving efforts centered on finding the "right answers" instead of searching for alternatives. Previous P2 success stories should be used only to provide ideas to the team using this problem-solving method. Because workers often wish to be involved in solving problems associated with their work, home-grown solutions are often more readily implemented than expert-generated solutions from the outside.

A simple cause-and-effect (fishbone) diagram can help the team examine how materials, machines (technology), methods, and labor contribute to the problem.

- Root cause analysis
- Cause and effect diagrams
- Fishbone diagrams
- Brainstorming
- Brainwriting

Step 4. P2 Decision-Making

Now the team must select an alternative to implement. A good tool for doing this is known as *bubble-up/bubble-down*. It is a forced-pair comparison of all the alternatives. Some teams prefer to use a criteria matrix or selection grid for rating each alternative against a predetermined set of criteria. Alternatives that are inexpensive and easy to implement go to the top of the list using the bubble-up/bubble-down tool. These "low hanging fruit" or "quick win" alternatives can often be implemented without much further study. More effective alternatives may require additional study. In some cases, a detailed feasibility study must be prepared. It is always beneficial from a team development perspective to have the "quick wins" precede these more complex programs.

To implement the alternatives, a written action plan should be prepared and submitted to management for review and approval. The key component of the P2 plan at the facility will be the action plans that are being implemented during the current year.

Now the team must select an alternative to implement.

- Bubble-up/bubble-down
- Criteria matrix
- Action plan

To implement the alternatives, a written action plan should be prepared and submitted to management for review and approval.

Step 5. P2 Program Management

This *Guide* suggests ways an organization can establish, implement, and manage its P2 program. The activities described in Steps 1

through 4 will take place within that program. While Steps 1 through 4 apply to many organizations, P2 program management (Step 5) must be designed to fit the culture of the organization using P2. The organization must provide training for the people participating in the program. There must be understandable policies and a management commitment. Relationships to other organizational programs must be clearly defined. Oversight for the P2 program can be provided in the form of program audits, by both internal and third parties. Finally, there must be a way to measure progress and evaluate the effectiveness of the P2 program. Some information that enables organizations to adapt the program management to their own culture is provided in Chapters 5 through 7.

ORGANIZATION OF THIS *GUIDE*

This *Guide* will provide information to help organizations get their P2 programs started or to help re-evaluate existing P2 programs. Chapter 2 provides some advice on how to get started with the P2 program process. The planning of the P2 program is covered in Chapter 3 and is discussed along with some planning elements that should be addressed. Most P2 programs can use tools (discussed in Chapter 4) to facilitate communication within the organization and between organizations. Tools that support the five-step model described previously are presented in Chapter 4. These tools can also be used in all of the implementation models covered in this *Guide*. Several models are presented to help in implementing the P2 program. A traditional P2 implementation model is presented in Chapter 5. It can be used with or without the tools presented in this *Guide.* Also presented is a version of this model called "Nothing to Waste" that is particularly useful to small organizations. Chapter 6 shows how an environmental management system (EMS) may be used to implement a P2 program. Chapter 7 presents a quality model that can be used to implement a P2 program. Chapter 8, the final chapter, examines how individuals can design and implement their own P2 programs from the materials presented in this *Guide.*
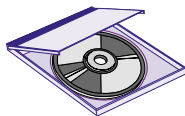
A companion CD-ROM is included to provide supporting information on all of these topics and additional information that may be required to plan and implement a P2 program for your organization. All of the referenced material is accessible through the CD-ROM. The following information is provided on the CD-ROM:

- P2 Checklists
- Links to Information on the P2 Tools
- Information on EMS to Support P2 Implementation
- Information on Quality Model to Support P2 Implementation
- Other P2 Manuals
- Other Sources of Useful P2 Information

The CD-ROM should be useful as your organization develops the P2 Program.

REFERENCES

1-1.   *Compliance Through Pollution Prevention (CTP2): Implementation Guide.* U.S. Air Force Material Command, Wright-Patterson AFB, December 2000.

1-2.   National Pollution Prevention Roundtable (NPPR) Web Site
http://www.p2.org/

1-3.   National Institute for Science and Technology Manufacturing Extension Program (NIST MEP) Web Site
http://www.mep.nist.gov/

1-4.   Small Business Development Centers (SBDC) Web Site
http://www.sbaonline.sba.gov/SBDC/

Other Sources of P2 Information

EPA Environmentally Preferable Purchasing (EPP) Program
http://www.epa.gov/opptintr/epp/

EPA Environmental Accounting Project
http://www.epa.gov/opptintr/acctg/

EPA Design for Environment
http://www.epa.gov/dfe/

EPA P2 Programs and Initiatives
http://www.epa.gov/opptintr/p2home/programs/index.htm

EPA P2 Resource Exchange (P2Rx)
http://www.p2rx.org/

EPA Sustainable Industry
http://www.epa.gov/sustainableindustry/

State P2 Programs
http://www.epa.gov/opptintr/p2home/resources/statep2.htm